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(54) Title: UNDERLAY SHOCK PAD

(57) Abstract

Underlay shock pad for preventing head injuries, such as fracture of the skull or concussion, caused by a fall, and for use in playgrounds for children and in other places, where there is a great risk that particularly children may stumble or fall down, said underlay shock pad being placed on a draining layer and being preferably provided with a hard-wearing membrane. In order to attain a considerable damping of in particular the frequencies causing the most serious head injuries, the underlay shock pad consists of mineral wool in the shape of plates, said mineral wool being a felt of mineral fibres, which in their intersecting points are bound together by means of a bonding agent distributed on the fibres over the whole thickness of the mineral fibre felt, the plates having a bulk weight of 70-300 kg/m^3 and a thickness of 30-100 mm.

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Underlay Shock Pad.

The present invention relates to an underlay shock pad of the kind stated in the preamble of claim 1. The underlay shock pad may be used in connection with the establishing of children's playgrounds. The underlay shock pad is preferably placed in areas, where the risk of children stumbling or falling down is greatest. By way of example the underlay shock pad may preferably be placed under swings, slides, and climbing frames.

According to literature available, such as for instance "Det Socialpædagogiske Fagblad, Børn & Unge", no. 33, it seems reasonable to assume that about 12,000 accidents take place every year in Danish playgrounds. Of this number approx. 3,000 are serious accidents. Quite a number of these accidents may be classified as falling accidents.

To prevent accidents due to a fall from causing serious injuries, such as for instance concussion or fracture of the skull, a number of different underlay shock pads is known, even though they are rarely seen.

In "Børn & Unge", page XI, a diagram showing the relationship between: Height of fall in meters and the character of the underlayer. Examples are given of an underlay shock pad consisting of among others a rubber mat, bark chips, fine shingles, and sand.

Such underlay shock pads are rather good and have good shock absorbing properties. However, the three last-named materials also possess some disadvantages, the most important ones being:

1. The underlayers are not very hygienic, as they preserve both moist and dust. Pets may relieve nature etc. therein.

2. In case of frost the underlayers may become just as hard as concrete tiles.

3. It may be difficult to move on the underlayers, and in particular it may be difficult to cross such underlayers with vehicles with wheels such as three-wheel bikes and the like.

4. The underlayers must be constantly kept in place, as, otherwise, they do tend to spread like for instance the sand in a sand box.

In connection with indoor physical exercises various mats are used as underlay shock pads, said mats consisting of a layer of foamed plastics provided with a hard-wearing canvas coating or the like. Examples of such mats are given in the specification to Danish patent application no. 2099/77 or Swedish publication no. 440,729. These mats are generally not suited for being permanently placed out of doors and consequently do not possess the properties necessary for preventing absorption of water. Besides, various types of artificial turfs are known, cf. for instance British Patent No. 1,341,891. However, these underlayers are complicated to produce and therefore rather costly.

Rubber materials may also have good shock absorbing qualities, but they may be so elastic that another type of injuries are caused thereby.

From "Biomechanics Vol. 3, pp. 239-247, 1970, STUDIES ON MECHANICAL IMPEDANCE OF THE HUMAN SKULL: PRELIMINARY REPORT, E.S. Gurdjian, V.R. Hodgson and I.M. Thomas, Department of Neurosurgery, Wayne State Univeristy, School of Medicine, Detroit, Mich. 48207, USA, a study on the effect of mechanical impedance of the human skull is known. The study shows among others that an impact on the forehead (the brow) at a frequency of 300 Hz may entail vibrations in the back of the head (the neck), said vibrations being thrice as big as the original impact due to the resonant frequency of the skull itself.

From the report the following excerpts are taken:
It is hypothesised that long duration impacts

(t > 0.005 sec) produce predominantly rigid body motion, because the frequency spectrum of the pulse is too low to excite the lowest natural frequency of the skull. Consequently, the driving force produces primarily a phase-linear acceleration of the skull and brain. Shorter duration pulses, particularly those with short rise time, have a broader frequency spectrum which can excite skull vibrations, thereby augmenting or modifying the skull flexure patterns produced by the force. It is not yet understood in what proportions these factors influence head injury, but impact head accelerations have been recorded opposite the blow for short duration impacts (t<0.004 sec) that do not correlate with rigid body acceleration sometimes being greater by a factor of 2.

The report further shows that head injuries occur, when impacts exceed 50 G. G corresponds to an acceleration due to gravity of 9.81 m/sec^2.

To reduce the number of head injuries caused by for instance a fall, the underlay shock pad therefore must secure so long a braking time that the vibrations of the skull on account of this fall outside the vibration frequency of the skull itself. The study shows that frequencies within the area of 300 - 900 Hz are the most dangerous.

The object of the present invention is to remedy the above-mentioned disadvantages in the known underlay shock pads. This means that an underlay shock pad is to be provided, the properties of which are not are not to any noticeable degree influenced by climatic conditions, and which is hygienic, not difficult to move on, and which can be crossed by vehicles with wheels and which is not likely to be spread and which has a good damping, particularly in the frequency area, which seems to cause head injuries such as fracture of the skull and concussion.

This is achieved by means of an underlay shock pad which is characteristic by the subject matter disclosed in the characterizing clause of claim 1.

As the underlay shock pad consists of a comparatively rigid and hard mineral wool with fibres fixed by means of a bonding agent, the low dependency on climate conditions is attained. The material itself is water-repellant due to the properties of the bonding agent, and the mineral wool plates act as an insulation for the underlaying drainage layer. Because of its rigidity, the mineral wool will not be diffuclt to pass either on foot or with children's bikes, and the plates are so heavy that they do not tend to be displaced or moved. Finally, falling tests with a mock-up head of a child show, that the mineral wool possess excellent damping properties, in particular in the critical frequency area between 300 and 900 Hz. Tests carried out with an underlay shock pad according to the invention show that a braking time for the falling mock-up head of a child of more than 4 mms is achieved, and in most cases more than 15 - 20 mms, from the moment where the head hits the underlayer until the movement of the head has stopped. The longer the time of braking of a falling object, the softer the warding off of the fall. The tests show that the mineral wool with respect to damping in the critical frequency area between 300 and 900 Hz possesses far better properties than does the most commonly used material, viz. gravel. As to hygiene the mineral wool is by far to be preferred to the gravel.

The mineral wool plates are characterized by not having a rubber-like elastic effect, such an effect being undesirable, as the counter-effect thereof may cause a reverse acceleration within the dangerous frequency area.

The underlay shock pad according to the invention is a slow material as far as movements are converned, said pad giving according to documented measurements vibration frequencies being rather far from the dangerous frequency area. Furthermore, the de-acceleration is measured to below 50 G, preferably 40-42 G. With respect to a concrete tile a de-acceleration of 140 G is measured under the same test conditons.

The invention shall be described in details in the

following with reference to the drawing, which shows the damping properties of various materials registered during falling tests with a mock-up head of a child.

The underlay shock pad according to the invention consists of one or more mineral wool slabs, the thickness of which is within the area of 30 - 300 mm. Preferably, thicknesses from 30 - 100 mm are chosen. By mineral wool plates, plates of a mineral fibre felt are to be understood in this connection, the fibres of which are in their intersecting points bound together by means of a bonding agent, usually a phenol resin. The mineral wool is preferably of a type having the fibres placed parallelly to the surface, and the bulk weight may be in the range of 70 - 300 kg/m^3. Preferably, mineral wool plates are chosen, the bulk weight of whom is in the range of about 150 kg/m^3. The mineral wool plates are being placed for example on an approximately plane and drained underlayer of gravel or the like. The drainage underlayer may advantageously be lowered in such a way that the surface of the underlay shock pad is in level with the surrounding ground.

The underlay shock pay may be ready-made from a factory in the form of mineral wool slabs in the size of for instance 120 x 120 cm. The upper side of the plates and the edges may be coated with a comparatively thin rubber plate ensuring a hard-wearing and non-skid surface.

According to another embodiment the mineral wool plates are laid out side by side on the draining underlayer, and if necessary a final covering and sealing of the complete surface is made. The final covering may consist of:

a bituminous adhesive,

a bituminous insulating paper,

a thin layer of a urethane two-component adhesive,

rough reinforcement web,

a thicker layer of a two-component adhesive with rubber granulate.

The total thickness of the covering is approx. 5 mm.

According to a third embodiment the underlay shock pad is composed by several on top of each other placed

mineral wool plates. The plates may vary as to thickness and bulk weight. Preferably, the plates having the biggest bulk weight are placed on top, as they may thus contribute to the distribution of pressure.

The membrane or the surface covering essentially aims at distributing the pressure for individual forces acting on the surface of the underlay shock pad. At the same time it is to give the underlay shock pad a non-skid and hard-wearing surface. It may also differ in colour, so that for example a read colour like the one used on a tennis court indicates, that the children are now moving into an area, where greater care is to be taken.

The surface covering may be made in many ways, which is not, however, of importance to the invention. According to another example the surface coating may be made of a layer composed by a reinforcing fleece, reinforcing glassfibre web or the like which is glued to the surface of the mineral wool plates. On top of this a comparatively thin layer of a rubber asphalt may be placed, or rubber granulate may be dispersed in the wet binder for binding the reinforcing web.

What is decisive is that the rubber layer may not become so thick that the above mentioned disadvantages of the rubber arise, and that the layer is not so rigid that the shock absorbing property of the mineral wool is spoiled. Consequently, the surface layer is therefore of a thickness within the area of 2 - 5 mm.

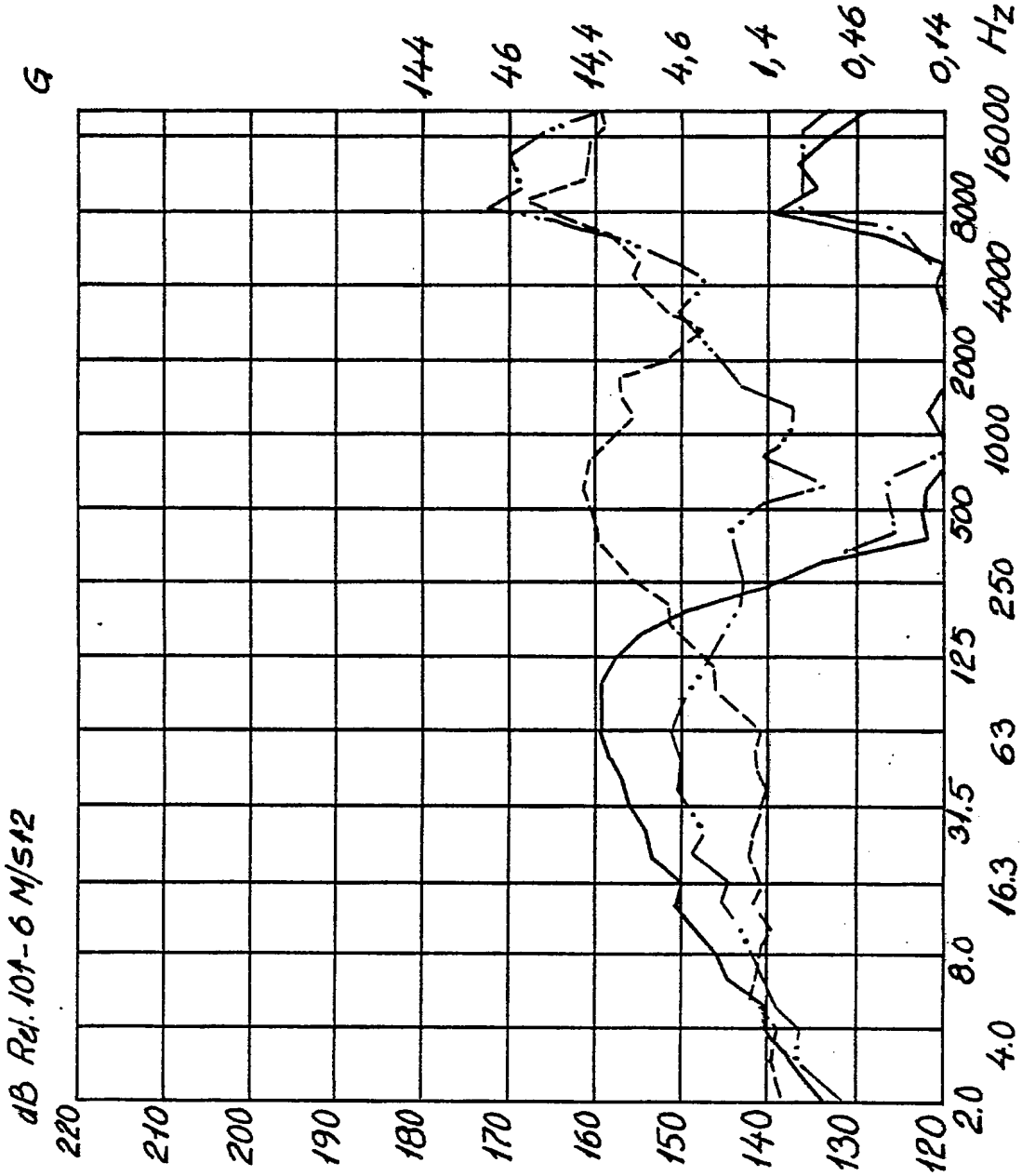
The drawing is a diagram showing the damping properties of various materials used as an underlayer in playgrounds. The properties have been listed on basis of falling tests with a mock-up head of a child. In the diagram the damping properties have been listed for various frequencies at a free fall of 60 cm. With a full-drawn line the properties of an underlay shock pad according to the invention is shown, said pad consisting of a 35 mm mineral wool plate with a bulk weight of 180 kg/m^2 and a bonding agent content of approx. 3% as well as a surface membrane mentioned above. By way of comparison the proper-

ties of the same mineral wool plate without a surface membrane have been indicated with a dot-and-dash line. It will be seen that the two curves are essentially converging, and that the surface membrane does not essentially deteriorate the properties, but on the contrary gives marginally better properties in the critical range between 300 and 900 Hz. Furthermore, curves are shown in the diagram for corresponding tests on 800 mm gravel (double-dot-and-dash line) and for 50 mm concrete tiles (dotted line). It will be seen that these materials often used as underlay shock pads in playgrounds for children are not particularly advantageous, particularly not in the for brain injuries critical range within 300 and 900 Hz.

Patent Claims

1. Underlay shock pad for preventing head injuries, such as fracture of the skull or concussion, caused by a fall, and for use in playgrounds for children and in other places, where there is a great risk that particularly children may stumble or fall down, said underlay shock pad being placed on a draining layer and being preferably provided with a hard-wearing membrane, c h a r a c t e r i z e d in that the underlay shock pad consists of mineral wool in the shape of plates, said mineral wool being a felt of mineral fibres, which in their intersecting points are bound together by means of a bonding agent distributed on the fibres over the whole thickness of the mineral fibre felt, the plates having a bulk weight of 70-300 kg/m^3 and a thickness of 30-100 mm.

2. Underlay shock pad according to claim 1, c h a r a c t e r i z e d in that the orientation of the fibres in the mineral fibre felt is essentially approximately parallel to the surface of the underlay shock pad.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INTERNATIONAL SEARCH REPORT

International Application No PCT/DK87/00071

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC 4

A 63 C 19/04, E 01 C 13/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC 4	A 62 B 1/22; A 63 C 19/00, /02, /04; E 01 C 13/00; E 04 F 15/22
US Cl	404: 17, 27, 28, 34, 35, 73, 75

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

SE, NO, DK, FI classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	GB, A, 2 142 353 (NORMAN WHARTON) 16 January 1985	1
A	US, A, 4 074 948 (GUY C HEATER JR.) 21 February 1978	1
A	DD, A, 88 107 (ELK RICHTER, JOCHEN MOTHES) 20 November 1972.	1

* Special categories of cited documents: [10]

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IV. CERTIFICATION

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1987-09-15	1987 -09- 18
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